**Supplementary material:
Addressing Marine and Coastal Governance Conflicts at the Interface of Multiple Sectors and Jurisdictions**

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## **Outline for evaluation of case studies**

Based on the key elements identified during presentations and discussions at the workshop, and bridging the different evaluative frameworks that were assessed, we proposed the following outline for evaluating case studies:

1. Who are the stakeholders involved and what are the ecosystem services / resources being managed?

2. What is the conflict? What are the underlying objectives and values, and to which stakeholders do they belong? What are the monetary values and non-monetary values of main stakeholder groups?

3. What/how much can be gained (or lost), and to whom, from improved coordination? What aspects of power dynamics affect the achievement of such coordination?

4. Are there processes in place to coordinate among these stakeholders, and cross-sectoral coordination/allocation mechanisms? Is there political will to establish and/or maintain that coordination?

5. Is there a comprehensive set of shared objectives and values across all, or a subset of stakeholders?

6. Are there processes in place for trade-off / synergy evaluation (including explicit assessment of distributional impacts)?

7. Do you think the proposed solutions so far are durable, and could be resilient to external changes / shocks?

8. What other aspects of governance of the conflict do you feel are key to understanding the possible solutions?

We argue that these 8 questions constitute a framework for characterizing empirical case studies of governance conflicts at the interface of multiple sectors and jurisdictions. The relevance of each question to critical aspects of case study evaluation is reviewed in the following table:

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| --- | --- |
| **Case study element** | **Diagnostic feature** |
| 1. Resources and users | 1a Define stakeholder participation  |
| 1b Define ecosystem services in consideration |
| 2. Externalities | 2a Identify conflict |
| 2b Define values (monetary and non-monetary) of stakeholder groups |
| 3. Distributional effects and power dynamics | 3a Identify benefits of coordination |
| 3b Identify beneficiaries of coordination |
| 3c Define stakeholders' political influence |
| 4. Coordination mechanisms | 4a Define existing coordination mechanisms |
| 4b Define support from central authorities |
| 5. Shared objectives | 5a Define management and stakeholder objectives |
| 5b Identify shared and conflicting objectives |
| 6. Evaluative processes | 6a Define existing processes for trade-off evaluation |
| 7. Solutions | 7a Characterize durability of proposed solutions |
| 7b Characterize resilience to external shocks |
| 8. Governance challenges and opportunities | 8a Identify barriers to possible solutions |
| 8b Identify opportunities |

## **Case study #1: Moray Firth Seal Management Plan**

The Moray Firth in north-east Scotland has Special Areas of Conservation (SACs) established for three marine protected species (bottlenose dolphin *Tursiops truncates*, harbour seal *Phoca vitulina*, and Atlantic salmon *Salmo salar*).The conflict centres around the balance between the conservation of harbour seals and Atlantic salmon - both protected but with one that preys on the other, although the impact of predation at the population level was largely unknown due to lack of adequate monitoring data.

The stakeholders involved in this case study include a range of interests that support seal conservation, such as wildlife tourism operators, conservation and animal welfare groups, and fisheries interests, such as commercial and recreational fisheries that view seal predation as having an impact on their livelihoods because of perceived impact of seals on salmon[[1]](#footnote-1). In addition other stakeholders are involved in the conflict including statutory organisations such as Scottish Natural Heritage and scientific research organisations and individuals at the local and regional level. The resources being managed are salmon and seal populations, and the livelihoods dependent on them.

The Scottish Government issued a Conservation Order in 2002 that prohibited the killing, injuring or taking of harbour seals. This was due to declining numbers of harbour seals, the potential consequence of an earlier Phocine Distemper Virus outbreak, and rumours of a bounty scheme whereby District Salmon Fishery Boards (DSFBs) were believed to be paying marksmen for shooting seals. With declining catches of salmon, and the imperative to protect salmon SACs, a bottom-up process triggered by salmon fishery stakeholders emerged in 2002 which aimed to balance seal and salmon conservation. The DSFBs and netsmen collaborated with the Scottish Government, the Government’s Fisheries Research Services, Scottish Natural Heritage, the Sea Mammal Research Unit (SMRU) and the Moray Firth Partnership (a forum representing local wildlife tourism operators, conservation groups and marine fishery interests) to develop the Moray Firth Seal Management Plan (MFSMP).

The plan was developed with a simple and shared objective in mind, namely to resolve the conflict between seal conservation and salmon fisheries. Animal welfare organisations did not share this objective. There was an incentive for the salmon fisheries stakeholders to engage in the process, since the status quo would leave them with no mechanisms to control seals’ impacts on salmon. The main party to lose out on the process was the animal welfare sector, which was campaigning to ban the shooting of any seals. The MFSMP allowed for a collective application annually by fisheries to the Scottish Government to shoot a limited number of individual seals most likely to be impacting on fisheries in confined Management Areas, away from seal pupping sites[[2]](#footnote-2),[[3]](#footnote-3).

A number of conditions enabled the successful negotiation and implementation of the MFSMP[[4]](#footnote-4). The first was a local ‘champion’ - a scientist employed by the Spey DSFB, with a background in wildlife conflict resolution and salmon management experience. A combination of a window of opportunity, the champion’s scientific background and sense of empathy for all interests made him the lynchpin of the process and trusted by the key stakeholders[[5]](#footnote-5). His facilitation enabled the integration of all relevant stakeholders on an equal footing and resulted in the MFSMP being endorsed by all stakeholders involved. The second condition was the involvement of the Scottish Government, which created a crisis point (in the form of the Conservation Order), resourced the process of developing the MFSMP, and endorsed any agreements reached, thereby legitimising the outcomes. The Scottish Government is still central to the process, as it receives and issues the annual licence applications, but it no longer resources negotiations amongst stakeholders.

The last condition, and one that has not been fully resolved, is the provision of adequate financial and local institutional support to ensure long-term implementation of the plan. Although local DSFBs have appointed a staff member to collate seal-shooting information and to submit the annual application, this has been insufficient to fund regular stakeholder coordination and interaction, and hence knowledge exchange, learning and innovation has dissipated since the MFSMP’s early years. As such, there are no formal or significant mechanisms in place for trade-offs/synergies evaluation (including explicit assessment of distributional impacts) and/or cross-sectoral coordination/allocation mechanisms.

The MFSMP has been monitored since 2004 by independent scientists with external funding. Longitudinal evaluations indicate that relative to 2004 the MFSMP has shifted from a community-led cooperative system to one which is increasingly government-led and instructive[[6]](#footnote-6): the system is “ticking along” with annual seal shooting licence applications being put to and approved by the Scottish Government, but local stakeholder engagement has declined. The intervention of a new animal welfare stakeholder in recent years has caused a further crisis point for the system. This may have the catalytic effect of restoring collaborative governance across levels, since the original aims of the MFSMP are being challenged, upsetting the status quo[[7]](#footnote-7).

## **Case study #2: Salmon management institutions in the Columbia River Basin**

Salmon management institutions in the Columbia River Basin involve a myriad of stakeholders. There are multiple ecologically-connected ecosystem goods that are valued by different stakeholders: water is valued for hydropower, recreation, transport, agriculture, salmon production; adult salmon are valued for harvest (commercial, recreational, tribal) and killer whales conservation; wildlife and biodiversity in general are valued by citizens (non-use sector) and for ecotourism. Sectors that can be managed to influence salmon production or salmon survival include human harvest, hatcheries, dams, irrigation for agriculture, predation, and habitat conservation and restoration. The interest groups include industry groups, recreational groups, tribes, non-governmental organizations (environmentalists and animal rights activists), municipalities, and citizens who benefit from cheap electricity produced by hydropower dams. The decision-makers include: federal management agencies in charge of fish and wildlife (National Oceanic and Atmospheric Administration, United States Fish and Wildlife Service), water resource management (United States Bureau of Reclamation), dam operations and flood protection (United States Army Corps of Engineers), and marketing power for federally owned hydropower dams (Bonneville Power Administration); but also fish and wildlife state agencies, Indian tribal governments, regional councils (Pacific Fishery Management Council, Northwest Power and Conservation Council), and courts that play an important role because there has been a lot of litigation around recovery plans.

Many salmonid populations in the Columbia River Basin are at historically low levels and are listed either as threatened or endangered under the US Endangered Species Act (ESA). Many dams, which are used for power production, flood control, navigation, and irrigation, are impeding in- and out-migration of salmon and blocking access to potential spawning habitats. Dam operators are tasked with maximizing multi-use operations while assuring economical and reliable power supply to the public as well as compliance with the ESA. Salmon conservation is also potentially conflicting with human harvest and with the protection of pinnipeds that prey on salmon. The salmon recovery issue is also closely linked to conservation of endangered southern resident killer whales as limited availability of prey species (salmon) is considered one of the biggest threats to this cetacean population. The various stakeholder groups that value different ecosystem services disagree on the nature of the problem: fishermen and tribes who want more salmon point to dams and habitat destruction; irrigators, loggers, and other river users accuse overfishing; and all use sectors also blame predation by marine mammals and birds, while non-use sectors criticize impactful human activities.

Hundreds of millions of dollars are spent annually on salmon habitat restoration. Other types of actions that have also been widely implemented include barging of juvenile salmon, screens and bypass improvements at dams, dam spills and flow operations for fish, wild stock supplementation via conservation hatcheries, and leasing water rights to enhance in-stream flow. Despite these efforts, salmon populations remain in peril. Improved coordination could lead to taking other types of action that have not been broadly implemented and could be more cost-effective such as breaching major dams, culling marine mammal predators, and eliminating harvest supplementation hatcheries. Implementation of these potential solutions is generally impeded by competing stakeholder interests and entrenched interests arising from management institutions. Improved coordination could also reduce litigation and uncertainty associated with litigation, which would benefit to stakeholders involved in ongoing legal battle.

The Northwest Power and Conservation Council, created in 1980, is a regional organization tasked to ensure the balance between environment and energy needs in the region. Its fish and wildlife plan is substantially devoted towards guiding project funding by the Bonneville Power Administration for salmon conservation and recovery. The development of the plan involves recommendations from the federal and state fish and wildlife agencies, local Indian tribes, and other interested parties. In 2017, the Columbia Basin Partnership Task Force, bringing together federal agencies, environmental, fishing, agricultural, utility, and river-user groups, local recovery groups, the states of Idaho, Montana, Washington, and Oregon, and local Indian tribes, was created to develop shared goals for the future of salmon in the Columbia River Basin.

The Columbia Basin Partnership Task Force initiative has worked out a set of provisional quantitative goals for natural production of salmon. However, there is no plan laying out how the goals might be achieved. In addition, these shared goals are only concerned with salmon and do not address objectives for ecologically-connected resources such as water and marine mammals.

Processes for evaluation of tradeoffs or synergies across sectors are currently limited. In 2016, the U.S. District Court for the district of Oregon required a new Environmental Impact Statement (EIS) to recover endangered salmon in the Columbia River Basin. This EIS, due in 2020, will examine the likely environmental, social, cultural, and economic impacts of multiple possible actions intended for salmon recovery. An EIS typically has input from many government agencies, non-profit organizations, business associations, consultants, and individuals. The courts play a critical role in ensuring actions to promote recovery continue, but they generally do not intervene in deciding what particular actions should be taken. Cross-sectoral coordination also occurs through the Northwest Power and Conservation Council and the Federal Caucus (composed of ten federal agencies working together for endangered salmon in the Columbia River Basin). However, there are no cross-sectoral allocation mechanisms in place.

Despite considerable efforts, all the actions undertaken over the last three decades have not allowed recovering endangered salmon. In particular, cross-sectoral conflicts have not been adequately addressed. Bringing back salmon will require that humans think about their values and the compromises they are willing to make. With potentially less favorable climate-driven environmental conditions in the future (both in freshwater and ocean environments), it is unlikely that salmon can be recovered without considerably reducing human impacts on salmon and their habitats, returning rivers to more natural states, and addressing predator control issues.

The fact that externalities occur across different ecosystem goods (water users impact salmon production, marine mammal conservation impacts salmon survival, salmon users impact killer whales conservation), across biomes (ocean, estuary, rivers), and across jurisdictional boundaries (multiple States, multiple sectors, multiple species) is likely to increase the transaction costs of collective action because of scientific uncertainty about externality costs, diverging preferences across parties, information asymmetry, and anticipation of non-compliance. Values and trade-offs are difficult to monetize or compare, and, since value generation is diffuse amongst many widespread and heterogeneous stakeholders, negotiation and compensation are extremely challenging. Therefore, designing governance structures that minimize transaction costs appears critical. In addition, the conflicts involve both use and non-use sectors so that solutions need to consider the important cultural values that salmon and killer whales hold in the region. This constrains the range of possible solutions as there is no straightforward way for use and non-use sectors to bargain to reduce externality losses.

## **Case study #3: International Whaling Commission**

The International Whaling Commission (IWC) was established 75 years ago as an organisation whose primary responsibility was managing the commercial harvest of large whales. Thus, the initial stakeholders were government and private sector representatives of commercial whaling operations. However, given the growing range of threats to whales that today far surpass the mortality from direct hunts, the IWC now has a much broader range of stakeholders. The participants of typical meeting of the Commission today number around 500 and include delegates from member countries (88), non-member countries, other Intergovernmental Organizations, and NGOs.

There are two basic conflicts: one is internal to IWC and stems from different views on the optimal ‘use’ of whales, i.e., should they be harvested commercially or for aboriginal subsistence consumption, or should they be left in the ocean for their ecosystem, intrinsic or other value? In the end, both ‘sides’ of this conflict are in agreement that recovery of whales is a positive trend, but there is disagreement on the optimal use of these recovered stocks given different ‘valuation’ perspectives. This internal conflict is not the focus of this discussion. The second and greater conflict is much broader and reflects the externalities imposed by other sectors on the recovery and long-term health of whale populations. These other sectors are not part of the regular IWC stakeholder groups despite being a threat to whales: fishing; underwater drilling and extraction; shipping noise and emissions, and other ocean pollution such as plastics. The externalities of these activities on whales are rarely if ever *internalized* into the decisions on production and consumption of these goods and services. somewhat ironically there is agreement from both ‘sides’ of the basic whaling issue that there is a need to address these other threats to whale population recovery in order to ensure healthy stocks (for whatever ultimate use). This broad range of threats from non-whaling sources suggests an equally wide range of valuation – e.g. maximizing lobster harvest, ensuring profitable fossil fuel production, moving goods from country to country via optimal shipping routes, and so forth. There is little to no consideration of the need to monitor and mitigate impacts on marine mammals from a private sector perspective, although certain regulatory requirements (such as environmental impact analyses) might require consideration of impacts on marine mammals. The sectors imposing these externalities and the incentives they have to address these externalities are far removed from proponents of marine mammal recovery, and therefore the transactions costs are extremely high.

In some cases, improved coordination can lead to *pareto optimal* exchanges in which these losses to the impacted stakeholder group can be offset by another stakeholder group or even government that is willing to pay for the improvements to the marine ecosystem. TheECHO program[[8]](#footnote-8) in Vancouver BC provides lower docking fees for vessels that slow their approach to the port and thereby reduce noise and emissions, as well as the probability of a ship strike. California State Government, with early support from NGOs, compensated shipping vessels whoreduced their speed in approaching west coast ports in exchange for some compensation[[9]](#footnote-9). Other possible gains from coordination emerge for some of these externalities such as marine mammal entanglement in fishing gear when operators have as much interest in avoiding bycatch as those pursuing mammal conservation and recovery. Every year fishery operators from the smallest offshore gillnets to high seas pelagic longliners incur costly damage to and loss of fishing gear (and possibly targeted species catch) from marine mammal encounters. In this case, there is a shared interest in finding ways to minimize these interactions to avoid such costs and thus there is an incentive to collaborate. Ecolabels and corporate reports on ‘green’ activities can provide incentives to fishery stakeholders to avoid marine mammal bycatch – and also be an acceptable approach for conservationists. The Marine Stewardship Council is currently in the process of revising itsbycatch standards for protected species as part of its regular Fisheries Standards Review[[10]](#footnote-10). In a similar incentivizing approach, the U.S. MMPAimport rulemaking requires other countries to have marine mammal bycatch standards that are ‘comparable in effectiveness’ to those in the United States in order to access the U.S. market[[11]](#footnote-11).

There are few if any established processes for this coordination and therefore they must be created and nurtured – mostly by the affected stakeholders and their relevant institutions. For example, the development of marine mammal bycatch guidelines at the FAO Committee on Fisheries was only possible due to parties (key countries, IWC and other IGOs, NGOs) who provided the funding and the expertise to partner with FAO to get this work agreed and completed. The IWC has invested funding (primarily voluntary funds) to engage with institutions such as the International Maritime Organisation to provide scientific and technical information geared at reducing shipping vessel speeds, noise and emissions. The IWC is also reaching out to the tuna RFMOs to raise awareness of the impact of fishing on marine mammals and to offer scientific, technical and policy expertise for monitoring and mitigation of bycatch through collaboration.

There has been much turbulence within the IWC in past years with acrimonious debate and a polarized Commission. While there has been an improvement over the past few meetings, for some stakeholders the IWC still has a reputation of being ‘dysfunctional’ and overcome by the ‘whaling wars’. This reputation has hindered the effectiveness of outreach to other IGOs to address common concerns. Some RFMOs for example would likely be somewhat wary about the discussion of marine mammal issues at their meetings given the potential for carryover of the acrimony of IWC debates into their meetings. The IWC is slowly developing social media and other communication efforts in order to increase awareness of its efforts to constructively address all impediments to recovery of whale stocks and to demonstrate its ability to implement a holistic approach to its mandate through cross-institutional, cross-sectoral cooperation.

It is only through these concerted efforts at cross-institutional collaboration that there can at least be an *understanding* of the different stakeholders’ and institutions’ objectives and values. It is not necessary for those to be shared values in order for the benefits of collaboration to occur. Only in the case of fishing gear damage or loss (and possibly predation losses) is there a shared objective of reducing encounters between fishing operations and marine mammals.

While there have been some success stories in addressing the impacts to marine mammals from other activities, each initiative is unique and must be designed, launched and nurtured for long-term, durable solutions. External shocks can and will have impacts; for example, changes in the prices of seafood products, fossil fuels, or the volume of international trade will directly impact the fate of marine mammals who incur injury and mortality from fishing, offshore drilling and seismic testing, and shipping. Any compensation scheme that is negotiated will likely also need to be adjusted as these prices fluctuate and therefore alter the true costs of adaptations taken in these sectors causing externalities to marine mammals. Ironically, any changes in the value of marine mammals (such as recentresearch estimating a value of up to $2m on each marine mammal for its carbon sequestration value) would not likely result in any change to a collaborative agreement[[12]](#footnote-12).

An important impediment to more integrated management systems is the lack of complete data and understanding of population-level impacts for marine mammals. In some cases, such as bycatch of vaquita in gillnets in the Gulf of California, we have nearly perfect information on the impacts of the fishery as the vaquita are nearing extinction. In the case of many small-scale coastal gillnet fisheries, there are very little data available on bycatch, much less an assessment of their population-level impacts. The Indian Ocean Tuna Commission (IOTC) estimates that 40% of the harvests under that RFMO is taken by gillnets, a unique feature of IOTC among the world’s five T-RFMOs. Yet data collection through logbooks, observers and other means lags far behind. As noted above, when the IWC approaches other organisations to make the case for addressing marine mammal bycatch, having solid scientific evidence is key to convincing these institutions to address the problem.

Another major challenge to more integrated management is that the benefits to marine mammals are often non-market in nature, while the costs to the sector imposing the externalities are monetary and more easily measurable. For example, the increased costs to fishery operators of using ropeless gear in a pot fishery are well documented, however generating an estimate of the benefits of lower rates of marine mammal injury and mortality is extremely difficult. There are studies of the value of recovery of marine mammals (such as Wallmo and Lew (2015)) who estimate of the value to U.S. households of North Atlantic Right whale downlisting under ESA) however these types of analyses and estimates are few and far between and the research is costly and time-consuming. Even with solid research results on non-market valuation of cetaceans, these estimates are often met with much scepticism when compared to easily calculated mitigation costs to a commercial sector such as oil extraction, fishing and shipping.

While threats to cetaceans are evolving, the basic objective of the IWC has not changed: ‘*A convention to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry.’* This IWC case study can provide unique insights into the challenges facing an international institution whose ability to adapt over the years to changes in the global governance framework and environmental context may be critical to meeting its objectives.

## **Case study #4: Management of Natural and Reared Salmon Stocks in the Baltic Sea**

Salmon seems to be, after wolf, the most political animal in Finland, and very much so in other Baltic Sea coastal countries. There are very strong natural stocks in the northernmost part of Baltic Sea, and their overall production is nowadays around 70% of the total salmon production, while it was less than 10% in the 1980’s. This creates a system where the management in north has a big impact on the whole Baltic Sea fishing.

The main stakeholder groups include professional off-shore and coastal fishermen, and recreational river fishermen. In addition, the tourism industry along the river valleys is an important player, as it is said that the total value of one landed salmon in river area is about 2000 euros, while the value in sea fishing is around 10 - 40 euros. The nature conservation organisations (Finnish Association for Nature Conservation and WWF) have been active in contributing to the policy to safeguarding the stocks.

It is obvious that, in the sea, the value of the fishery is linearly linked to stocks and thereby on catches. However, for river fishing, the mechanism seems to be that the catch per unit effort (CPUE) must be high enough (some kind of trigger value) to keep the fishermen yearly interests up, and the area specific tourism active. Therefore, the optimal distribution of biomass and catches is not a trivial task to estimate in any economic analysis.

The conflict with seals has been obvious since a strong recovery of seal stocks. Now there seems to be a balance in the seal stocks, and the hunting is allowed by applying a quota, but technically the hunting is very difficult (shooting from a boat to the sea, or on sea ice in early spring time) and the quotas are not taken. There is some evidence that grey seals gather to the river-mouths at the time when smolts leave the river, and even though this is a relatively short period, the impact on salmon stocks may be high. The structure of trapnets has improved markedly, and the seals cannot enter the trapnets to eat the salmon inside.

The main management conflict is a classical one: who has the licence to kill? Historically, the reason for poor river catches has always been claimed to be the off-shore and coastal fisheries, and the poor coastal catches have been said to be due to the off-shore fishing, etc. At the time when reared stocks were the majority of mixed stocks (up to 90 %), no one was blaming that the part of recruitment potential is lost due to high fishing mortality, but now during the last 20 years the high natural production has created a question: does the overall fishing pressure decrease the recruitment and thereby every fisher group’s catches? This should create an interest to co-operate more, but it also requires an understanding of stocks assessment tools (and belief in results), to understand how gains and efforts interact in various areas and fisheries.

By improving the natural recruitment, the current management system has shown its power. Historically a key management action was an establishment of a stepwise opening of coastal fishery from south to the north in Finnish coastal waters (4 zones) which ensured a certain proportion of migrating spawning stock to enter the spawning rivers. This helped both Swedish and Finnish stocks, even though the political will to do something was based on a single minister in Finland (the only fisheries minister who was not selected from political parties). The same system is basically applied still in Finland, and it can be seen as a biomass-independent management of fishing mortality, while in TAC policy one must correctly, or at least with some precision, predict the biomass to effectively use TAC as a control tool. It is natural that the management need in Sweden is decreased by the Finnish system, and all those Baltic Sea countries that fish on off shore area, get benefits in terms of improved catch options.

In all EU fisheries management (mainly the sea fishing) the key objective is to reach MSY. In the case of salmon, this means that smolt production is about 75% of the maximum. Twenty years ago it was basically impossible to say what is 100% level in each salmon river, and thereby the aim of those days, 50 % of maximum smolt production, was politically easy to decide. However, from operational management point of view, this was difficult to assess on a yearly basis. The same challenge is true for MSY, but the decreased fishing mortality has led to such river specific production estimates, which slowly allow assessing the maximum productivity and thereby support the operational implementation of MSY policy in the future.

Compared to e.g. herring stock dynamics, a key element of salmon stock productivity is the short life cycle. Parrs stay 2 - 4 years in rivers (depending how south - north the river is) and in 2 sea years, salmon reach 5 - 8 kg weight and return to home rivers. In a case mortality is changed in any part of the life cycle, there is a possibility to see a fast response in recruitment. The recovery of the stocks (end of 1990’s, 2000’s) happened quickly and it was even possible to follow single year classes in the stock status data sets. Moreover, the data sets cover the whole life cycle and stock assessment is carried out by some of the most comprehensive techniques, so the basis for decision making in management are very good. The stock may collapse again due to high increase of M74 (mortality of eggs and fry, linked to sprat stock biomass), but the informative assessment and the good response to actions help Baltic Sea salmon stocks.

ITQ systems have been applied in many Baltic Sea countries, but there are not many systematic evaluations available. In Finland, the system was discussed for a long time, and both scientists and nature conservation NGOs demanded that the trade of the quota should be made possible to take place between the different fisheries. As there is a lot of capital in river fishing (fishing cottages, companies, etc.) and the value of a catch is high, many experts believed that the yearly, historical fight on “who has the licence to kill”, could have been solved by ITQ trade. However, in the last meters the political decision was that each fishing segment (off shore, coastal, river) must have their own quotas without trade between them.

The coastal fishing is not focusing only on salmon. Sea trout stocks are likely in worse condition than the salmon stocks, and in salmon trap nets there is a high by-catch of sea trout. Sea trout feed along the coast, in shallow areas, which means that the local gill net fishing creates a high fishing mortality. The additional mortality from trap-nets may be too much for their life cycles. Historically, whitefish (Coregonus lavaretus, spawns in rivers) trap-nets were used with a clear interest to catch salmon as “by-catch”.

## **Case study #5: Interactions between seals and commercial fishing in Ireland**

The Irish Wildlife Act (1976) and subsequent Wildlife Amendment Act (2000) make it an offence to hunt or injure seals up to 12 nautical miles offshore unless permission is granted from the relevant government minister. Recent population surveys suggest that seal populations are increasing: Ireland’s current grey seal population numbers approximately 7,824 – 9,365 animals of all ages compared to 5509 – 7083 in 2005. Growth in the grey seal breeding population appears to have continued since the mid 1990’s and possibly dating to the early 1980’s. The population of harbour seals for the entire island was estimated at 6950 in 2003. Recent aerial surveys resulted in counts exceeding 2003 figures by 18.1%. Both species are considered to be of Least Concern (low risk of extinction) according to the International Union for Conservation of Nature (IUCN).

Data gathered in Ireland suggest that the grey seal is the primary species involved in interactions with commercial fisheries in inshore set net fisheries. A 2010 questionnaire in relation to seal depredation distributed to fishermen through the Federation of Irish Fishermen (FIF) provides a more recent qualitative assessment. Depredation rates of 20 – 30% were reported across gill net, tangle net and trammel net fisheries for pollack, monkfish, cod, hake and turbot in coastal and offshore locations along the west, south and east coasts. More recent studies (Cosgrove et al 2013) on the west coast of Ireland have shown that averages of 18% of pollack, 10% of hake and 59% of monkfish landings were depredated by seals. Proportions of fish damaged and related economic impact of seal depredation in set net fisheries have substantially increased since the 1990’s. Total loss of landings could rise to over 50% in both the pollack and hake fisheries when potential numbers of fish entirely removed from nets were taken into account. The upper limit of the total annual value of seal damaged fish in pollack and hake set net fisheries is €1.7m.

This has led to a clear conflict in interests between the fishing industry and those involved in conservation, particularly environmental non-governmental organizations (eNGOs). Responsibility for seal conservation and seal interactions with fishing also tend to involve two different government departments. The goods and services provided in this case are principally the provisioning services from a fishery which can be very important in rural west Ireland, and for the cultural services (existence value) of the seals. The fishers wish to see population numbers of the seals being controlled, reducing the considerable depredation on their fishing activities. The eNGOs would like to see the populations continue to recover from their historic lows after hunting was banned. Those responsible for conservation in the government aim to comply with national and international legislation. Broadly, this stipulates a stable or growing population.

It is not clear what can be gained by improved coordination in this interaction. Legislation prevents the culling of seals, while this course has been advocated by fisher’s groups. The eNGOs are also concerned about seal bycatch in the fisheries, which does occur in these fisheries, but not apparently at a level that impacts on the population sustainability. The best route forward is likely to involve mitigation of the depredation by the seals. Operational mitigation measures carried out at the fisheries level offer the most potential as solutions in the short term. Smart fishing techniques such as deployment of gear for short periods and working gear in relation to changes in tidal currents are essential to reduce depredation in inshore waters. Faster hauling speeds could reduce depredation and a variety of operational practices can also be considered. Systems which actively deter seals from the vicinity of vessels such as acoustic deterrents have strong potential to further mitigate seal depredation in deep set net fisheries. Some coordination, to help both sides understand the other’s views would be useful though. In terms of power dynamics, neither party are particularly powerful politically, and struggle to get their points of view taken into account by national authorities.

An ad hoc group was established some years ago to bring the parties together, but this was unofficial and had no direct mandate. It was successful in the task of getting each side to understand the position of the others. It ceased to operate in recent years with the loss of some key members. It is not clear at present how much political will there is to re-establish that coordination, but it is not strong.

As noted above, there are conflicting objectives for the fishers and the eNGOs. The fishers’ perception is primarily about loss of income and difficulty in operations. The eNGOs are promoting the conservation and protection of the seal populations and probably an increase in those. So the fishers have primarily monetary values, and the eNGOs principally non-monetary. There are no processes in place for tradeoffs/synergies evaluation and cross-sectoral coordination mechanisms are lacking.

The current position is not particularly durable or resilient. The issue of depredation emerges periodically via press articles, and parliamentary questions, leading to a brief flurry of attention, which then dissipates. Essentially none of the proposed solutions (mainly in mitigation) have been taken beyond the pilot phase. Arguably, the separation within national authorities of the issues of seal conservation and the impact of those seals on the fisheries is one of the key issues. There is no specific responsibility for seal depredation, and the legislative responsibility for seal conservation is being met for the time being.

## **Case study #6: Water supply and salmon in California’s Central Valley**

The state of California, on the west coast of the United States, has long been the setting for conflict over the allocation of a scarce natural resource, fresh water, between multiple, diverse sectors. In recent years, one of the highest profile conflicts has been trade-offs between use of water for irrigated agriculture and for provision of habitat for Pacific salmon. California is characterized by a Mediterranean climate with a high-degree of intra-annual variability in precipitation. Summers are hot and dry; nearly all precipitation falls during the wet winter season, much of it accumulating as snowpack in the Sierra Nevada mountains. In addition, California is also characterized by a high degree of inter-annual precipitation variability, with frequent droughts and years with above average annual precipitation.

The Central Valley of California is defined by the watersheds of the Sacramento and San Joaquin Rivers. Runoff and river conveyance in this region is the foundation of water supply for human use in California. More than 35 million residents derive a portion of their drinking water from this watershed, including the cities of San Francisco and Los Angeles, but the bulk of water abstracted from this system for human use is used for irrigated agriculture. Farms in this region produced over $US 50 billion in 2017, much of it from high-valued crops such as almonds, pistachios, citrus fruits, and vegetables.

The Central Valley is also home to four Evolutionarily Significant Units (ESUs) of Chinook salmon (*Oncorhynchus tshawytscha*), an iconic species with significant cultural value and historically the basis of a highly valuable fishery up and down the US Pacific coast. The Central Valley ESUs are the southernmost spawning populations of Chinook salmon in the northern hemisphere. Central Valley Chinook salmon are anadromous fish. Animals spend most of their adult lives in the ocean, return to their natal rivers at approximately age 3, spawn and die. Juveniles emerge from eggs laid in rivers, rear for a time in freshwater, and emigrate to the ocean. The timing of adult migration and the amount of time spend in freshwater as juveniles varies by ESU. Freshwater habitat degradation has led to a long-term and significant decline in population status for all of these ESUs, with two being listed as endangered under the US Endangered Species Act (Winter-run and Spring-run). Construction of dozens of dams in the Sierra Nevada throughout the 20th century blocked salmon from over 80 percent of their historical spawning habitat. The remaining available habitat for spawning and rearing has declined substantially in quality and quantity because of large-scale water diversions for human use, especially irrigated agriculture.

California is a water-limited environment, which makes the marginal value of water in all uses potentially very high. These high values are the source of the conflict between water uses, particularly between irrigated agriculture and the instream flow to support juvenile salmon survival. The availability of surface water for irrigation is an important constraint to agricultural production and can induce significant economic and social impacts, particularly during severe or prolonged droughts[[13]](#footnote-13),[[14]](#footnote-14). Similarly, an increasingly large body of evidence from ecology shows that instream flow conditions are a primary driver (perhaps the most important driver) affecting the productivity and viability of salmon stocks[[15]](#footnote-15). Adding to the intensity of the conflict is that each unit of water can, in most cases, be used by only one of the competing sectors. Water diverted for irrigation cannot be effectively re-used for salmon habitat, because return flows are insufficient and of degraded quality. Similarly, water used to provide better instream flow conditions for fish is not available for abstraction and farmers often complain that this water is “lost to the sea”.

Water supply in the Central Valley is a highly engineered and intensively managed system. The US federal government and the California state government operate two extensive water storage and conveyance systems in the region: the Central Valley Project (CVP) and the State Water Project (SWP), respectively. The purpose of the two systems to maximize water deliveries to agricultural and municipal water users. This objective is subject to the constraint that ecosystem function goals must be met, including minimum standards for endangered species such as Chinook salmon.

Governance of the water supply system is a patchwork of federal state and local agencies. Water operations (direct management of dams, reservoirs, and canals) is done by the US Bureau of Reclamation and the California Department of Water Resources. Dams that produce hydropower are also subject to regulation and permitting requirements by the US Federal Energy Regulatory Commission. Species protection is overseen by two federal agencies, the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service and the US Fish and Wildlife Service (USFWS), and a state agency, the California Department of Fish and Wildlife (CDFW). Delivery of water directly to agricultural users is done by irrigation districts. These districts are special, quasi-independent entities created under state law. They have some of the administrative authority of local governments but are independent and have a specific purpose, in this case to deliver water to customers.

Operation of the system CVP is subject to the US Endangered Species Act (US ESA) because some Chinook salmon ESUs, and another fish, Delta smelt, are listed as endangered. Section 7 of the of the US ESA requires all federal agencies to ensure that the actions they fund, authorize, or carry out are not likely to “jeopardize” a species or “destroy or adversely modify” critical habitat. In the Sacramento-San Joaquin basin the USBR must consult with the US Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to satisfy this requirement. Consultations typically start as discussions between the Service and a federal agency to determine whether the agency’s proposed actions may affect a listed species. Formal consultations end with a Service “biological opinion,” which contains information on how listed species are affected by operations of the CVP and rules for operating the project in ways that minimize harm to listed species.

Conflicts between interests groups often play out in the form of interest group politics and litigation. There is some, limited potential for improved coordination between sectors. For example, in the northern Sacramento Valley region, rice farmers have coordinated with state and national wildlife agencies and environmental NGO’s to manage flooded fields to create or enhance floodplain habitat[[16]](#footnote-16).

There is a long, and well-studied, history of institutions developed in the hope of providing processes to coordinate among stakeholders and to develop and implement policy in the basin. CALFED, a collaborative governance program, was created in 1994 following several consecutive years of drought. CALFED was a partnership of the federal and state governments with a mandate to find collaborative solutions to issues in four areas: water quality, water supply, levee stability, and ecosystem restoration. Participation included 30 interest group organizations representing agricultural water users, environmental groups, municipal and industrial water users, and fishing industry groups, along with 25 state and federal agencies. Despite efforts to find and implement policy solutions, fish populations and water quality continued to decline through the mid-2000s and CALFED dissolved in 2007[[17]](#footnote-17),[[18]](#footnote-18),[[19]](#footnote-19). By 2013, a new governance body, the Delta Stewardship Council, was established to facilitate stakeholder involvement and implement policy.

## **Case study #7: St. Croix River alewife restoration**

This case study describes issues surrounding attempts to return the anadromous alewife (*Alosa pseudoharengus*) to the St. Croix River, which forms part of the international border between Maine USA and New Brunswick Canada. The St. Croix River and watershed once supported large runs of anadromous alewife, shad and salmon. Alewives were important as food to the Indigenous Passamaquoddy People (who have inhabited the area for thousands of years), and were fished heavily by European settlers prior to about 1825. Alewife migrations were interrupted by dams that spanned the full river beginning about 1830, and populations were further impacted negatively by deteriorating water quality due to logging and industrial development. Attempts to facilitate recovery in recent decades have been complicated by different values placed on ecosystem services and by complex jurisdiction.

This case study involves the recovery of a native species (alewife) that was effectively extirpated from much of its range due to human activity. It is a species valued by Indigenous Peoples for food and for its role in the ecosystem. Alewife is acknowledged to be a major forage fish that is important to both freshwater and marine ecosystems. Dams on the St. Croix River system provide power for manufacturing and control river flow for a variety of industrial, recreational and other aesthetic values. The lakes at the head of the St. Croix system are valued for sport fisheries that have developed, especially for the introduced smallmouth bass.

The conflict over recovery of the alewife has evolved over the past 4 decades. Prior to 1980, fishways on the four major dams that span the St. Croix River were either absent or ineffective. In 1981, the completion of a new fishway at lower Milltown Dam resulted in a resurgence of the alewife population in the St. Croix system. Between 1981 and 1987, alewife returns increased from 169,000 to 2,625,000. But this alewife resurgence coincided with a drastic decline of smallmouth bass in Spednic Lake, and raised concerns that the increased alewife population might be negatively impacting smallmouth bass, which had become the basis for an active sport fishery guiding sector. As a result of these concerns, and in response to a strong lobby from bass fishing guides, alewives were blocked from Spednic in May of 1987 and, as part of an assessment program aimed at developing a long-term alewife management plan, alewives were temporarily blocked at the Grand Falls dam in 1991. In 1995, the State of Maine enacted emergency legislation to close both the Woodland and Grand Falls fishways to migrating alewives. After these closings, the St. Croix alewife population fell from a high of 2.6 million fish in 1987 to a low of only 900 returning adults in 2002. The Milltown Dam was not subject to the 1995 legislative action and, beginning in 2001, the Canadian Department of Fisheries & Oceans began trucking alewives from the Milltown fishway 16 kilometers (10 miles) upstream to the Woodland Flowage where they were released to spawn. The Government of Canada consistently called for the St. Croix River to be opened to alewife passage. This effort allowed the alewife run to rebound to about 12,000 in 2006.

The major stakeholders and issues are summarized in the following table:

|  |  |
| --- | --- |
| **Major stakeholder/sector** | **Position/issue** |
| Indigenous (Passamaquoddy) Peoples, Environmental NGO’s | Alewives are critical to ecosystem and as food source |
| Businesses (paper and power companies) | The dams of the St. Croix river, while old, are still valuable in their contributions to industry and power generation |
| Government of Canada (Department of Fisheries and Oceans) | Alewives are a native species and should be returned to native habitat |
| Government of the State of Maine | Faced with conflicting objectives of Passamaquoddy Tribe who want to promote alewife recovery and bass fishing guides who have preferred to prevent alewife recovery. |
| Bass fishing guides | Perceived a negative interaction between alewife restoration and bass productivity, so argued against restoration |

This case study is interesting from several perspectives:

1. It is an example of inconsistent management approaches in neighbouring jurisdictions. At one point the State of Maine was trying to prevent alewife passage while Fisheries and Oceans Canada was trucking alewives to upper reaches of the river.

2. The rationale of preventing alewife passage to protect bass fishing means that recovery a native species was being stalled to protect an introduced species of commercial (recreational) value

3. The argument that alewife recovery is detrimental to bass productivity is generally thought to be incorrect. In other rivers of Maine where alewife population have recovered, bass populations are doing well. The drop in bass population numbers in the mid-1980s is thought to be due to a drawdown of water levels during spawning rather than to alewife recovery.

The governance surrounding this issue is complex. St. Croix activities are governed by State/Province and Federal Canada/USA departments. There are many issues (including fisheries, recreation, industry) and several jurisdictions (including Governments of Canada, New Brunswick, USA, Maine, the Passamaquoddy people and communities). There is the important voice of the Passamaquoddy People on both sides of the river, and increasing interest from the public and NGOs. There has been no single, agreed governance structure within which this issue could be resolved.

As an international boundary, the St. Croix has a bi-national Board under the auspices of the International Joint Commission (IJC). In 2005 the International Joint Commission’s St. Croix River Watershed Board issued a discussion paper on alewife in the St. Croix outlining the scientific case for reopening the river. This review of existing research showed that alewives were native to the watershed and that alewife – bass interactions were beneficial. The research noted that because the alewife must swim upstream to spawn, they are vital to the food web and nutrient cycles of marine, freshwater and land habitats in the basin. As bait, they also help support coastal fisheries and lobstering. While the IJC St. Croix Board has no direct authority related to alewives, it has provided a forum for synthesis and cross-boundary discussion aimed at preventing or reducing transboundary conflict.

## **Case study #8: Depredation by whales in French Antarctic toothfish fishery**

The resources managed in this case study are toothfish (*Dissostichus eleginoides*), which is targeted by French longline vessels in French Antarctic territories, and sperm whales (*Physeter macrocephalus*) and killer whales (*Orcinus orca*) interacting with this fishery. The French Antarctic toothfish fishery is MSC (Marine Stewardship Council) certified since 2013 for Kerguelen zone and since 2017 for Crozet. The MSC accreditation has been re-certified in 2018[[20]](#footnote-20). At the international level, the main stakeholder involved is the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), which sets conservation measures that determine the use of marine living resources in the Antarctic, based on the best available scientific information. At the national level, the French Government (ministries and the territorial administration – Terres Australes et Antarctiques Francaises, TAAF) is in charge of managing the fishery. Other stakeholders involved include scientists (for toothfish stock assessment and quota recommendation, marine mammals and birds assessments), environmental NGOs (whale protection), and fishing industry actors.

Depredation – retrieval of fish from fishing gear by animals – of toothfish by sperm whales and killer whales is generating conflicts between the fishing industry and marine mammals’ conservation objectives. Depredation often results in (i) socio-economic impacts (e.g. fish losses, damages on equipment, extra fishing effort to complete quotas or to implement strategies of avoidance), (ii) biological impacts on targeted fishes (directly generates uncertainty in stock assessment and indirectly increased the fishing pressure), but also on depredating species (e.g. bycatch, lethal responses from humans), and in (iii) ecosystem impacts (e.g. changes in predator behavior and distribution, impacts of artificial supply, disruption in energy flows). In addition, sperm whales and killer whales are iconic protected species that have important non-use value for environmentalists and the public.

Conservation objectives require minimizing depredation-type interactions by non-lethal measures, such as implementation of vessel avoidance strategies and / or development of catch protection systems. In addition, depredation, as a behaviour providing killer and sperm whales with access to a highly energetic prey requiring low capture effort, may enhance the demographic performances of killer and sperm whales populations, and therefore may contribute to population enhancement.

Current coordination between stakeholders and sectors exists and is substantial. One of the main reasons is that it is a simple system with few actors involved. The toothfish fishery is the only commercial activity and is constituted of a small fleet of seven vessels. Data is collected on 100% of fishing operations and is available to scientists and authorities. Research programs are co-funded by the industry, in collaboration with the TAAF. While coordination is advanced compared to other fisheries, there is still a lack of knowledge regarding the overall impact of depredation on the toothfish stock and the associated marine ecosystem. Further research is thus needed to see if it is possible to mitigate the phenomenon and improve the state of the whales stocks without impacting the toothfish stock.

Despite the existing coordination, fishing industry actors are generally unhappy with the current situation, as they complain about depredation and decrease in quotas due to depredation. Therefore an improved coordination could be beneficial. However, there is very little hope that a technological solution limiting loss of fish could be found without completely changing the fishing technique (longline). The public perception of the impacts of the fishery on marine mammals may not be a strong issue in this zone. Each vessel has an observer on board and therefore it is not possible for fishermen to shoot or voluntarily harm marine mammals. However, illegal fishing still exists and then shooting can happen.

The regulation of the fishery is based on licenses, quota and measures to regulate the activity (to protect seabirds and marine mammals). The quota allocation between vessels are based on historical catches (32%), environmental (28%), fishing capacity (12%), compliance (16%), socio-economic (12%) criteria. Importantly, depredation is taken into account in the quota process. So, at least implicitly, there is a cross-sectoral allocation mechanism (the more depredation occurs, the lower the toothfish quota will be).

Furthermore, researchers benefit from the support of ship-owners in multiple ways such as video cameras to better observe the marine environment during fishing and participation to research on depredation by killer whales. This collaboration between the industry and the research sector is enhanced through the implementation of a quota allocation criterion based on the participation to research activities. This criterion is based on participation in experiments, scientific campaigns or the installation of new equipment useful to scientists (cameras in particular). Additionally, the funding provided by the selling of fishing rights[[21]](#footnote-21) related to toothfish fishing are used, among other things, to support scientific activities, scientific monitoring of authorized fisheries, and the fight against illegal fishing. In general, there is a political will to maintain the coordination, including the fight against illegal fishing that involve government and industry stakeholders.

The MSC certification provides an important framework for shared objectives and demonstrates that the fishing industry is involved in biodiversity preservation (collaboration with scientists, funding for research programs). However, although the conservation objectives are relatively well understood by the fishing industry, it is hard to say that protecting the whale populations is a shared objective. Indeed, it is mostly seen as a constraint. The non-monetary benefits of conservation are not at all measured and shared. The monetary losses are only supported by the fishing industry. Although depredation is included in the toothfish quota calculation, there is no clear trade-off evaluation. To date, the distributional impacts of whale conservation are rather unknown.

The equilibrium of the socio-ecosystem is fragile; therefore it might not be resilient to changes or shocks. For instance, the socio-ecosystem may not be resilient to drops in the price market of toothfish, and/or increase in the frequency/severity of depredation interactions, and/or collapse of fish stocks. Together or separately, these factors could induce the costs of depredation (extra fishing effort) to potentially exceed the benefits associated with the catch. The governance system in place could allow for adaptive co-management, providing rapid feedbacks on the outcomes of depredation mitigation actions. If further developed, adaptive co-management could improve the durability of the system.

Proposed solutions to mitigate depredation include a possible diversification of target species for the current toothfish fishery. The Mackerel icefish (*Champsocephalus gunnari*), which is caught in the same areas as toothfish and promoted by the TAAF, has been the subject of several attempts. However, its economic model has not been convincing (the production seems rather fluctuating and the opportunities remain to be developed). Some ship-owners also plan to develop new methods of fishing or to invest in boats adapted to the ice to access new fishing zones outside French waters. In addition, solutions advocated by environmental NGOs include the establishment of a sanctuary in the whole Antarctic area[[22]](#footnote-22).

Regarding a potential compensation scheme, it should be noted that the EMFF (European Marine and Fisheries Fund) allows compensations for similar depredation phenomenon occurring in specific inland aquaculture facilities. The compensations are provided based on article 54 of the EMFF Regulation[[23]](#footnote-23) (‘Aquaculture providing environmental services’), and concerns fish losses generated by birds in aquaculture farms located in NATURA 2000 sites due to specific environmental restrictions in these areas.

Key aspects to investigate further – that will help proposing effective solutions to the depredation issue – include evaluations of (i) the non-monetary benefits of conservation, (ii) the overall ecosystem impact of depredation, and (iii) the sensibility / dependency of the fishing industry to depredation.

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